OROVILLE FACILITIES RELICENSING
(PROJECT NO. 2100)

SP-F16
EVALUATION OF PROJECT EFFECTS ON INSTREAM FLOWS AND FISH HABITAT
PHASE 2 STUDY PLAN

REVIEW DRAFT

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RECOMMENDATIONS FROM PHASE 1

Collect Additional Targeted Hydraulic Data

Analysis of the existing hydraulic data base for the DWR instream flow studies (TRPA 2002) indicates that there are not enough transects available to adequately represent the current morphology of the Feather River and generate robust probable suitability index (PSI) functions. The specific reasons for this conclusion are 1) high flows have caused a degree of channel change since the transects were first measured and some new data is warranted, 2) common habitat types are represented by too few transects, especially straight flat water pool, 3) significant habitat areas were not included in the original study, such as lateral bar complex, 4) riffle transects did not specifically represent all available chinook salmon spawning habitat, 5) the study site selection process description was incomplete and appeared somewhat subjective, 6) only half of some split channel transects were used and given double weight, and 7) many transects are calibrated with only two instead of three or more stage-discharge pairs.

Additional data collection under Phase 2 should be conducted according to standard, established PHABSIM methods, including reach delineation, macrohabitat delineation, transect/site selection and placement, flow level determination, depth, velocity, and substrate/cover data acquisition, computer model construction and calibration, species evaluation and PSI computation, analytical procedures, further interpretation, and time series analysis. The previous approach to reach delineation, macrohabitat delineation, and transect/site selection and placement was thorough and defensible and should be adequate for Phase 2. At least six new transects are recommended to be placed in pool habitat in both the upper segment and lower segment, along with another six targeted spawning transects in both reaches (24 total). The target for weight of any given transect of any macrohabitat type should be 5% or less to minimize potential uncertainty. One 2-D site in each reach may also be selected in island or lateral bar complex habitat that includes the entire habitat unit.

Recalibrate the Amended Hydraulic Data Base

Once the gaps in the hydraulic data base are corrected, all original transect and supplemental hydraulic data should be calibrated to current acceptable standards. Issues to be addressed for one-dimensional modeling should include variation in flow computation by transect, stage-discharge rating curves (e.g. mean errors, slopes, intercepts), velocity simulation patterns (especially stream margin velocities), range of hydraulic simulation, and velocity adjustment factors. For two-dimensional modeling the files will need to be calibrated to show appropriate

velocity magnitude and direction patterns, realistic water surface elevation slopes and directions, reasonable Froude numbers, and satisfactory grid density and triangulation assignment.

Determine the Habitat Suitability of Deep Water

One of the potential data gaps remaining in the DWR micro-habitat database is the assessment of deeper water areas for rearing juveniles. Because most of the surveys were conducted near the stream margin and from the water's surface, relatively little effective effort has been allocated to deeper water. Consequently, defining the suitability of deeper water for HSC will be highly subjective and may be prone to disagreement. A traditional method of assigning suitability to deeper water is to keep the value at 1.0 into infinity. Although this decision may be appropriate for some species and life-stages (e.g. adult sturgeon), for others it is likely to yield unrealistic results in a PHABSIM analysis. Keeping in mind that HSC are probability-of-use criteria, while it may be true that juvenile chinook salmon, for example, can be found in deep water, it is less likely that they will be found there with the same probability as in shallower water.

Biologists working on the Feather River have indicated that chinook salmon spawning in deep water is extremely unlikely due to the unavailability of suitable gravels and flow characteristics in deeper areas, and thus the spawning HSC curve should follow the decline in use to low suitability in deeper water. Biologists working with juveniles have likewise indicated that juveniles are rarely observed in deeper water away from the margin areas. Most chinook salmon and steelhead emigrate from the Feather River at smaller sizes and thus few remain that would be expected to utilize deeper, offshore areas. The low densities of larger fish would make an assessment of deep water suitability difficult; however a study designed specifically to compare densities of fish at different depth intervals is likely to yield a general relationship between depth and fish densities. Such a relationship could then be used to scale the suitability of deeper water in a manner similar to the Gard method of adjusting deep water suitability for spawning (Gard 1997).

Create New Combined and Adjusted HSC

After a continuation of the analysis of the existing DWR micro-habitat data and the ongoing 2002 results, new HSC should be developed for use in the Feather River . Combining data from the three juvenile rearing studies will offer a large data set for HSC development. Various alternative approaches to combining the data should be attempted because of the difficulties associated with determining sampling effort among the habitat types. One option is to first generate separate HSC for pools, run/glides, and riffles. Then, each of the three data sets would be weighted according to the relative fish densities in each habitat type (so the habitat type with the highest densities would have the highest weighting factor). After weighting, the three data sets would be combined and normalized into an HSC curve. This method essentially simulates an equal-area sampling approach, where the relative number of fish observations per habitat type is determined by the density of fish in each habitat type. If a comparison of the weighted HSC and habitat availability data (also weighted to simulate equal-area sampling) suggests habitat limitations, the option of developing some form of use/availability (ratio) HSC would be explored. Other forms of HSC, including binary HSC, "envelope" HSC (Hardy and Addley 2001), or "composite" HSC (TRPA 2002) will also be evaluated once the 2002 data become

available. All HSC developed from the DWR micro-habitat studies will be compared to HSC developed from other large California rivers.

Validate the New Final HSC

Direct observation surveys within 1D or 2D modeling reaches surveyed during Phase 2 should be used to validate the ability of new site-specific (or existing) HSC to successfully predict fish habitat use. See the discussion under "Task 2 Category 2: Methods for Validating 2D Models" for details.

PHASE 2 SCOPING PROCESS FOR ADDITIONAL HYDRAULIC DATA

The recommendations for additional study sites and transects were evaluated by interested Oroville Project Relicensing resource agencies and stakeholders. The first step in the scoping process was to distribute the Phase 1 evaluation report (TRPA 2002) for review, discussion, revision, and concurrence as to the adequacy of existing data and need for and amount of additional data. The existing logistic framework established for the overall relicensing process, including technical review by the Environmental Work Group (EWG) and oversight by the Plenary Group, served as an instream flow study scoping mechanism. The Phase 1 review report was presented to and evaluated by the EWG, a Draft Phase 2 additional study report was discussed by members of the EWG, and a field trip was conducted to evaluate potential study sites and place additional transects.

The method outlined for site selection in DWR (1992) provided a template for identifying candidate sites, and the original decision-making process of site ranking was replicated. The transect types identified as deficient in the Phase 1 review were straight flat water pool and known spawning riffle and/or run/glide areas, where transects could either be located in previously-selected habitat units or in units given higher star ratings where no transects had been placed. Candidate sites for 2D hydrodynamic modeling could consist of the lateral bar complex units previously eliminated from the study in both the upper segment and lower segment.

Phase 2 Scoping Issues

Geographic Study Area

The original IFIM study implemented by DWR and Technical Review Team defined the study area for PHABSIM transect placement as extending downstream from the Fish Barrier Dam to Honcut Creek. "The salmonid studies will focus on the river segment where most of the spawning habitat occurs, from Feather River Hatchery to the Honcut Creek confluence (Painter et al. 1977). Habitat evaluation of the area below Honcut Creek (river mile 44) is of lower priority because of its lower habitat value to salmon… [T]he habitat needs of rearing salmon and yearling steelhead below the Honcut Creek [confluence will be addressed] through the development of a temperature model…" The Phase 2 scoping participants concurred with the definition of the instream flow study area as ending at Honcut Creek and restricted study site selection to upstream of the Feather River confluence with Honcut Creek.

Instream Flow Study Methods

The DWR instream flow study identified the IFIM "in conjunction with temperature (e.g. SNTEMP) and sediment transport studies…as the primary tools which will be used to evaluate the proposed action. These methods will be used in conjunction with other information, including expertise of scientists familiar with the area in making the assessments. Additional issues to be addressed in the study include an evaluation of the potential impacts of expected flow changes on riparian habitat, threatened and endangered species, recreational use of fish and wildlife, and screened and unscreened water diversions." This process will continue to be followed, because "Internationally, an IFIM-type approach is considered the most defensible method [of instream flow analysis] in existence… A microhabitat approach such as [PHABSIM] is still state-of-the-art internationally for in-depth studies of flow/instream biota interactions." (Dunbar et al. 1998). One-dimensional transects will continue to be the basis for PHABSIM analysis, with selective supplementation of two-dimensional model sites as warranted by physical conditions.

Number of Study Sites

DWR (1992) established a total of fifteen study sites where cross-sectional transects were placed to collect hydraulic data for PHABSIM. These sites were distributed throughout the study area and are believed to reasonably describe the variability of Feather River longitudinal physical habitat conditions. The Phase 1 review concluded that some additional sites could be utilized to fill minor mesohabitat-type data gaps and provide further coverage of habitat variability. Table 2 in the Study Plan (DWR 1992) identified Lower Eye as a potential site (2 stars) in the Upper Reach, and Hamilton Slough and McFarland Riffle in the Lower Reach.

For use in development of this Phase 2 Study Plan, the original process of site selection using ranking criteria was updated by DWR (Figures 1 and 2) in anticipation of a confirming field site visit. Three criteria for selecting study sites were established during preliminary scoping on 7 August 2002: 1) updated 1992 site ranking, 2) lateral bar complex (LBC) mesohabitat sites previously omitted, and 3) known salmon spawning areas. Selected study sites would have 1-D transects placed to represent straight flatwater pool and salmon spawning. The use of 2-D sites was recommended in Phase 1; however, EWG discussions have demonstrated a greater degree of agency interest in 2-D modeling as a potential Protection, Mitigation and Enhancement (PM&E) tool instead of as an existing habitat evaluation tool. Since some agencies have not made a formal decision regarding 2-D, the 7 August scoping meeting resulted in a decision to establish downstream control sections below potential 2-D sites as a "placeholder." With a downstream control stage-discharge rating curve, the topography needed to develop a 2-D model can be collected under lower flow conditions, and a final decision deferred.

Number of Transects

A total number of 1-D transects in the range of 20 has been shown to define weighted usable area relationships as well as a substantially greater number (Payne, unpublished data). There are currently 15 usable transects measured in the Upper Reach and 16 in the Lower Reach, with the possibility of four more (2 upper, 2 lower) available if they can be adequately calibrated. Six

new transects were proposed in Phase 1 for placement in straight flatwater habitat type in each reach, plus up to another six transects in known spawning areas within each reach, for a total of 24 new transects. This would result in up to 29 transects in each reach, plus a 2-D site in each, and assure the computation of robust WUA functions.

Transect Placement Field Site Visit

Field site visits to select transect locations were conducted on 8 August 2002 in the Upper Reach and 9 August in the Lower Reach. Jet boat access was provided by DWR, and agencies and stakeholders were represented by National Marine Fisheries Service and U.S. Fish and Wildlife Service. Starting upstream in the Upper Reach, transects were placed at Auditorium Riffle (2 pool, 2 spawning), Trailer Park (1 pool, 2 spawning), Weir Riffle (2 pool), and Eye Riffle (1 pool), for a total of 6 pool (the recommended number) and 4 spawning transects. Fewer spawning transects than the recommended 6 were added because a consensus was reached that all spawning areas in the Upper Reach had been adequately represented. Hatchery Riffle, although an important spawning area, was too complex (mid-channel lateral flow) to model with 1-D. The pool transects at Auditorium Riffle, Weir Riffle, and Eye riffle can also serve as 2-D study site placeholders.

In the Lower Reach, transects were placed in Conveyor Belt Riffle (1 spawning), Upper Hour Riffle (1 spawning), Lower Hour Riffle (1 pool, 1 spawning), Palm Avenue Pool (1 pool, 1 spawning), Hour Pool (1 pool), Big Bar (1 pool), Upper McFarland (1 pool), Boat Launch Pool (1 pool), and Junkyard Riffle (1 pool, 1 spawning). The total of pool transects (7) is one more than recommended in Phase 1, and the total of spawning transects (5) is one less, but the consensus was that all areas were adequately represented. The pool transects at Lower Hour and Junkyard Riffle can also be 2-D study site placeholders.

Additional detail describing the rationale for selection specific transect sites is provided in Attachment A. Maps illustrating the general location of proposed transects and the specific locations of existing IFIM/PHABSIM transects along the Feather River are provided in Attachment B.

Target Flow Levels

In the previous DWR study, model calibration data was measured at flows of approximately 400, 600, and 1000 cfs in the Upper Reach, and 1000, 2500, and 3000 cfs in the Lower Reach. Data collection on additional supplemental transects does not have to occur at these precise flows, but should be roughly equivalent to allow for similar range of extrapolation when all transects are ultimately merged. Flow regimes in both reaches are different now than in 1992/93 and constrain remeasurement of the previous flows. Target flow levels for the additional work are proposed to be approximately 600, 1000, and 1800 cfs in the Upper Reach, and 1500, 2750, and 5000 cfs in the Lower Reach. These flows would be used for calibrating the stage-discharge relationships of both the 1-D and 2-D models.

Target Velocity Pattern Flow Levels

Measurement of a single, high flow pattern of velocities extrapolated over the complete range of flows dictated by stage-discharge relationships has been shown to compute PSI results nearly identical to that computed from multiple velocity patterns (Payne 1988). Velocity patterns on the additional Feather River transects are proposed to be acquired at the highest physically-safe flow, anticipated to be 1800 cfs in the Upper Reach and 5000 cfs in the Lower Reach. 2-D model calibration does not rely on any measured velocity data but propagates depths and velocities upstream from a boundary stage-discharge rating through a topographic matrix.

Flow Measurement Schedule

The schedule of flow management in the Feather River provides higher levels of flow in the summer, tapering off to lower levels in the fall as water demand from Lake Oroville recedes. Flows in the fall and winter are constrained by consideration of salmon and steelhead spawning, where higher levels that might be present long enough to permit spawning must be maintained through the egg incubation and fry emergence periods. The window for data acquisition in the Feather River therefore starts to close in late August/early September, after which higher flow levels cannot be provided by flow control until spring. To avoid extension of field work until 2003, hydraulic data acquisition is proposed to be conducted the week of August 19-23, 2002 in the Lower Reach and the week of August 26-30, 2002 in the Upper Reach.

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Feather River Upper Reach

				Downweighted Criteria (from ' 91-92)								
Location	Channel Type	Good Example of Reach	Backwater Effect/ Transverse Flow	Habitat Diversity	Previous Transects	Access	Unlikely to Be Disturbed	Steelhead Rearing	Salmon Spawning	' 91-92 Rating	' 91-92 Transect?	Current Rating
Hatchery Riffle	IRC	OO	OOO	OO	OO	OOO	O	OOO	OOO	OO	x	
Auditorium Riffle	SFW	OOO	OOO	OO	O	OOO	O	OO	OOO	OO	x	
Oroville Backwater	IBC	OO	OOO	O		OOO	O	O		O		
Upper Bedrock Pool	SFW	OOO	OOO	O		OOO	O	O		O		
Bedrock Park Riffle	IBC	O	OOO	OO	OO	OOO		OO	OOO	O		
Bedrock Park	SFW	OOO	OOO			OOO	O	O		O		
Hwy 162 Bridge	SFW	OOO	OOO		OOO	OOO	O	O		O	x	
Trailer Park Riffle	IBC	OO	OOO	OO		OO	OO	O	OO	O		
Mathews Riffle	SFW	OOO	OOO	OOO		OO	OO	OO	OOO	OO	x	
Aleck Riffle	IBC	OOO	OOO	OO	OO	OOO	OO	O	OO	OO	x	
Great Western Riffle	SFW	O	OOO	O	OO	OO	OO		OO	OO	x	
Upper Robinson	SFW	O	OOO			OO	OO	O		O		
Robinson Riffle	IBC	O	OO	OO	O	OO	OO	O	OO	OO	x	
Steep Riffle	IBC	O	O	OO	OOO	OO	OOO	OOO	O	O		
Weir Riffle	SFW	OO	OOO	O	OO	OO	OOO	O	OO	OO	x	
Eye Riffle	IBC	O	O	OO		OO	OO	OO	O	O		
Lower Eye	SFW	OOO	OO	O		OO	OO	O		OO		
Gateway Riffle	IBC	OO	O	OO	OO	OOO	OO	O	O	O		
Gateway Pool	SFW	OOO	O			OOO	OO			O		
Thermalito Pool	SFW	OO	O			OOO	O			O		

Figure 1. Feather River Upper Reach revised transect ratings

Feather River Lower Reach

			Downweighted Criteria (from ' 91-92)									
Location	Channel Type	Good Example of Reach	Backwater Effect/ Transverse Flow	Habitat Diversity	Previous Transects	Access	Unlikely to Be Disturbed	Steelhead Rearing	Salmon Spawning	' 91-92 Rating	' 91-92 Transect?	Current Rating
Hamilton Slough	SFW	O	O	O	O	OOO	OO	O	O	OO	x	
Big Hole Islands	IRC	OO	OO	OOO	OO	OOO	OO	O	OO	OO	x	
Hour Riffle	SFW	OO	OOO	OO	OOO	OO	OO	O	O	OO	x	
Lower Hour	IBC	OOO	OOO	OO		OO	OO	OO	OOO	O		
Hour Glide	SFW	OOO	OOO	OO		OOO	OO	O	OO	OO		
Hour Pool	SFW	OOO	OOO			OO	OO	O	O	OO		
Keister Riffle	IBC	OOO	O	OOO	O	OO	OO	O	OO	O		
Goose Riffle	SFW	OOO	OOO	OO	OOO	OO	OO	O	O	OO	x	
Big Riffle	SFW	OOO	OOO	OO	OO	O	OOO	O	OOO	OO	x	
Upper MacFarland Pool	SFW	OOO	OOO	OO		O	OOO	O	O	O		
MacFarland Riffle	IBC	OOO	OO	OOO	OO	O	OOO	O	O	OO		
Developing Riffle	SFW	OOO	OOO			O	OOO	O		O		
Swampy Bend	IBC	O	OOO			O	OOO			O		
Gridley Bridge	SFW	O	OOO			OOO	OO			O		
Boat Launch Pool	SFW	OO	OOO			OO	OO			O		
Gridley Riffle	IBC	OOO	O	OOO	OO	O	OOO	O	OO	O		
Gridley Pool	SFW	OOO	OOO			O	OOO			O		
Junkyard Riffle	IBC	OOO	O	OO		O	OOO	O	O	O		
Junkyard Pool	SFW	OOO	O			O	OOO			O		
Lower Junkyard Pool	SFW	OOO	OO	O		O	OOO			O		
Cox Riffle	IBC	OO	OO	OO		O	OOO		O	O		
Cox Spillway Pool	SFW	OOO	OO			O	OOO			O		
Shallow Riffle	IBC	OO	O	OOO		O	OOO		O	O		
Upper Heringer	SFW	OOO	OOO			O	OOO	O		O	x	
Herringer Riffle	IBC	OO	OO	OOO		O	OOO	O	O	OO		
Herringer Pool	SFW	OOO	OOO	O		O	OOO			O	x	
Long Glide	SFW	OOO	OOO			O	OOO			O	x	
Confluence	SFW	OO	O			O	OOO			O		

Figure 2. Feather River Lower Reach revised transect ratings

Attachment A

Proposed transects for reach of the Feather River extending from the Fish Barrier Dam to the Thermalito Afterbay Outlet (Upper Reach):[1]

Proposed spawning transects in Auditorium Riffle (2): Two additional spawning transects are proposed at this location because this area is highly utilized by spawning salmonids and therefore warrants increased representation. Additionally, only one spawning transect existed at this site, and it is difficult to capture the lateral extent and the diversity of spawning habitat using only one transect. In order to represent the extent of spawning habitat available when one transect is used, the transect must be carefully weighted to incorporate the lateral extent of spawning habitat. Addition of transects in this area will provide additional representation of the extent of spawning habitat. The photograph shows the Auditorium Riffle area on the right.

Proposed pool transects downstream of Auditorium Riffle (2): Two additional pool transects are proposed at this location because the pool transect in the Auditorium Riffle area in the original study was dropped and therefore there is no pool transect representing this portion of the river. Additional representation of pools is necessary because pool habitat is a dominant habitat type and was underrepresented in the original study. These pool transects could serve as a downstream control point for potential 2D modeling.

Proposed pool transect upstream of Trailer Park Riffle (1), proposed spawning transect at Trailer Park Riffle (1), and proposed spawning transect downstream of Trailer Park Riffle (1): Three additional transects (one pool, two spawning) in the Trailer Park Riffle area are proposed because Trailer Park Riffle has experienced increased utilization as spawning habitat since the time of the original study. It was not included in the original study because it was not as heavily utilized by spawning salmonids at that time. This area was chosen to represent utilized spawning habitat that is not represented in the existing transects. The two photographs illustrate the areas in which spawning transects are proposed.

[1] *Note:* Photographs provided represent the area in which transects will be placed. The photographs do not represent specific transect delineations, but are provided to give the reader a picture of the river in the proposed transect area.

Proposed pool transects downstream of Weir Riffle (2): Two additional pool transects are proposed at this location because using the existing Weir pool transect, a large percentage of WUA for fry and juvenile chinook salmon for the whole Upper Reach comes from one part of the Weir pool transect. During the site visit it was postulated that the potential inundation of benches on the western side of the river channel at high flows could be the reason that the Weir pool transect is driving the WUA. While such benches exist in the immediate vicinity of the Weir pool transect, they are not found throughout the Upper Reach of the river. As a result, the existing transect may be viewed as representative of the area, but not of the entire Upper Reach. Therefore, two additional pool transects are recommended to provide additional representation of pool habitat in the Upper Reach which is more typical of the Upper Reach and which will serve to de-emphasize the proportional weight of the existing Weir pool transect. This pool transect could serve as a downstream control point for potential 2D modeling. The photograph shows the Weir pool area near the existing pool transect.

Proposed pool transect downstream of Eye Riffle (1): One additional pool transect is proposed at this location because an additional pool is needed in the Upper Reach to increase the representation of the currently underrepresented straight flat water pool habitat. Additionally, the Eye Riffle area is hydraulically complex and the pool transect downstream of Eye Riffle could serve as a downstream control point for potential 2D modeling. This transect will be located upstream of the current rotary screw trap site.

Proposed transects for reach of the Feather River extending from the Thermalito Afterbay Outlet to confluence with Honcut Creek (Lower Reach):

Proposed spawning transect at Conveyor Belt Riffle (1): One additional spawning transect is proposed at this location because a pool and glide transect were taken in the Conveyor Belt Riffle area, but no spawning transect was taken in this location. The transect will be located in the area between the previously established pool and glide transects.

Proposed spawning transect at Upper Hour Riffle (1): One additional spawning transect is proposed at Upper Hour Riffle to augment the existing spawning transects in the Lower Reach and because this area is utilized by spawning salmonids. The transect would stretch from the west shore to the point of the island and then across to the next island, making this transect a double dog leg transect across the head of the spawning area. The photographs show the spawning area at Upper Hour Riffle.

Proposed spawning transect (1) and pool transect (1) in Lower Hour area: One additional spawning transect is proposed at this location because Lower Hour Riffle is used by spawning salmonids and was not included in the original study. This transect will be placed across the island at Lower Hour in the spawning area. One additional pool transect is proposed at this location because the pool habitat is typical of the area, and because this pool transect could serve as a downstream control for potential 2D modeling.

Proposed spawning transect (1) and pool transect (1) at Palm Avenue boat launch: One additional spawning and one additional pool transect are proposed at this location because additional pools and spawning transects are needed to increase the representation of spawning and pool habitat to de-emphasize the proportional weight on existing transects. This transect pair will be located near the Palm Avenue boat launch and will provide representation of typical habitat in this area. The photograph illustrates the pool near the boat ramp.

Proposed pool transect at Hour Pool (1): One additional pool transect is proposed at this location because additional straight flat water pools are necessary and the pool is representative of the habitat in this area.

Proposed pool transect upstream of Big Bar (1) and Upper MacFarland pool transect (1): Two additional pool transects are proposed in this location because straight flat water pools are the dominant habitat type in this area and they are underrepresented. This area was not previously transected.

Proposed pool transect at Boat Launch Pool (1): One additional pool transect is proposed in this location because the pool is characteristic of straight flat water pool occurring between the Gridley boat launch and the confluence with Honcut Creek.

Proposed spawning transect (1) and pool transect (1) in Junkyard Riffle area: One additional spawning and one additional pool transect are proposed at this location because additional transects are needed to increase the representation of spawning and pool habitat to de-emphasize the proportional weight on existing transects. The spawning transect will be located at the head of Junkyard Riffle. The pool transect will be placed downstream of Junkyard Riffle in Junkyard Pool and could serve as a downstream control point for potential 2D modeling of the hydraulically complex Junkyard Riffle area. The photograph shows the Junkyard Pool area.